completing the energy sustainability puzzle

ENERGY and WATER

Western Region
Needs-Assessment Workshop

Salt Lake City, UT
January 9-11, 2006

Why are we here?

Workshop Purpose, Scope, Goals, and Context

within

DOE Energy-Water Technology Roadmap

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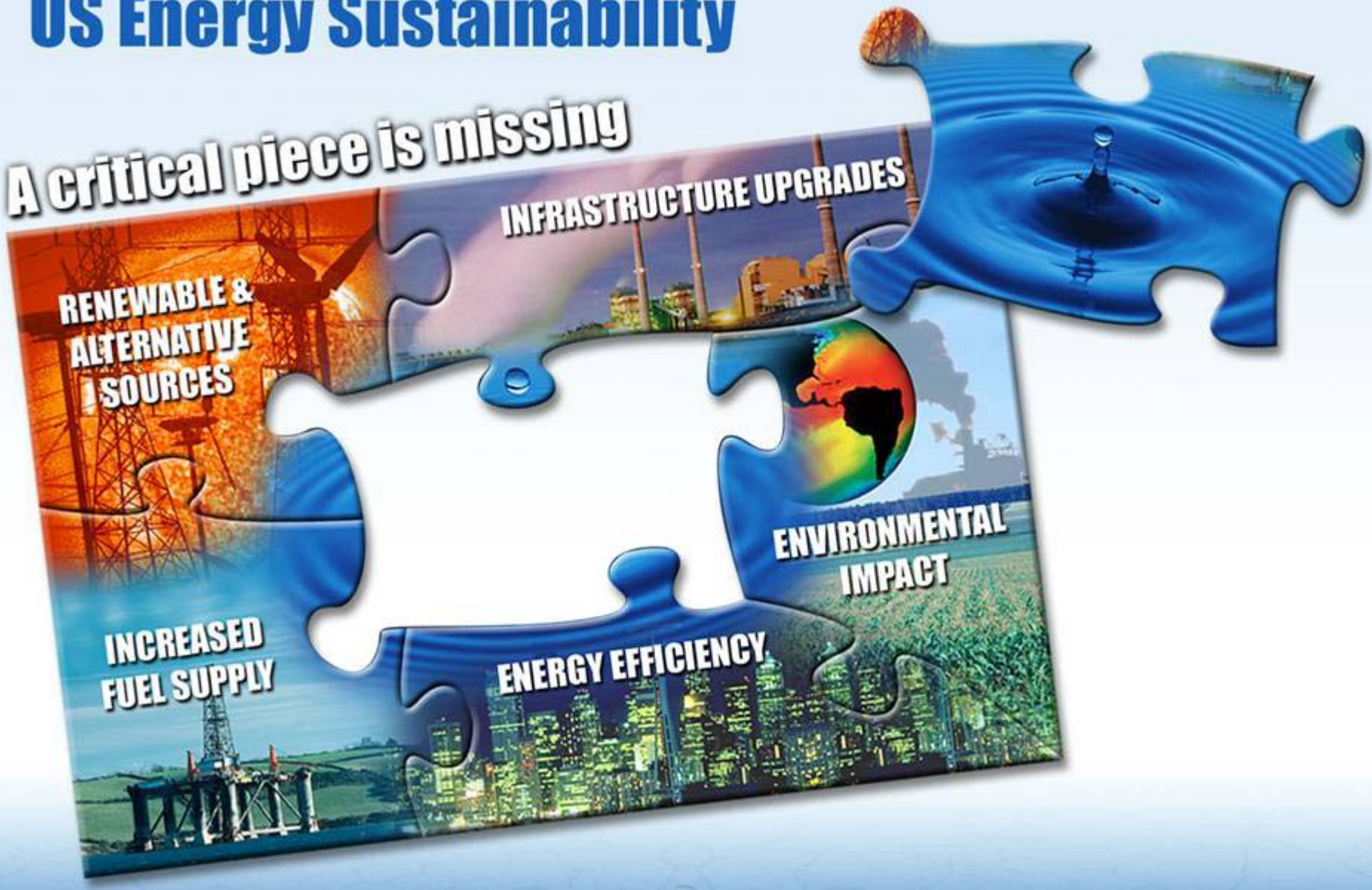
Energy-Water Needs Workshop

- Input phase for DOE Energy-Water Technology Roadmap in FY2006
- E-W Roadmap goal is to identify & rank innovative science and technology research to support DOE in meeting future energy reliability
- Focus on emerging problems, issues, concerns, and needs pertaining to the complex interdependencies of Energy & Water
- Interested in a broad spectrum of regional, state, and local stakeholder input
  - Energy companies, electric utilities, water utilities, water managers, economic development interests, energy regulators, water policy and regulatory interests, environmental groups, tribal nations, other water-use sectors
- Needs assessment results will be used to:
  - Identify gaps
  - Help rank regional and national priorities
  - Provide input on science & technology R&D and implementation

Setting the Stage

Energy-Water Nexus Overview

US Energy Sustainability



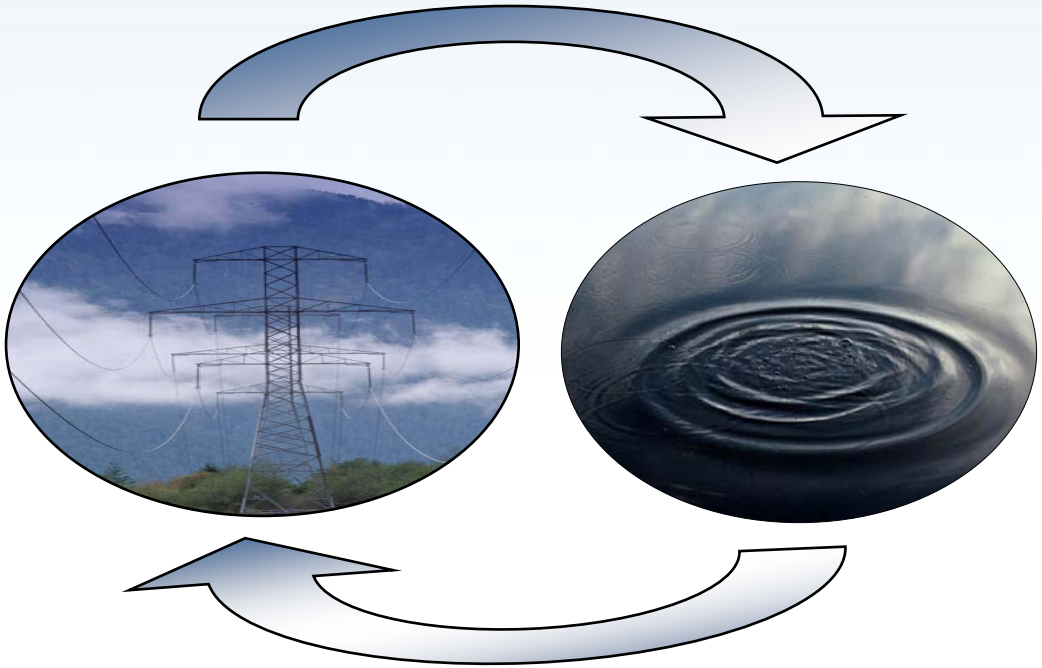
ENERGY and WATER

Energy and Water are linked:

Energy for Water and *Water for Energy*

Energy and power production requires water:

- Thermoelectric cooling
- Hydropower
- Energy minerals extraction / mining
- Fuel Production (fossil fuels, H_2, biofuels / ethanol)
- Emission controls

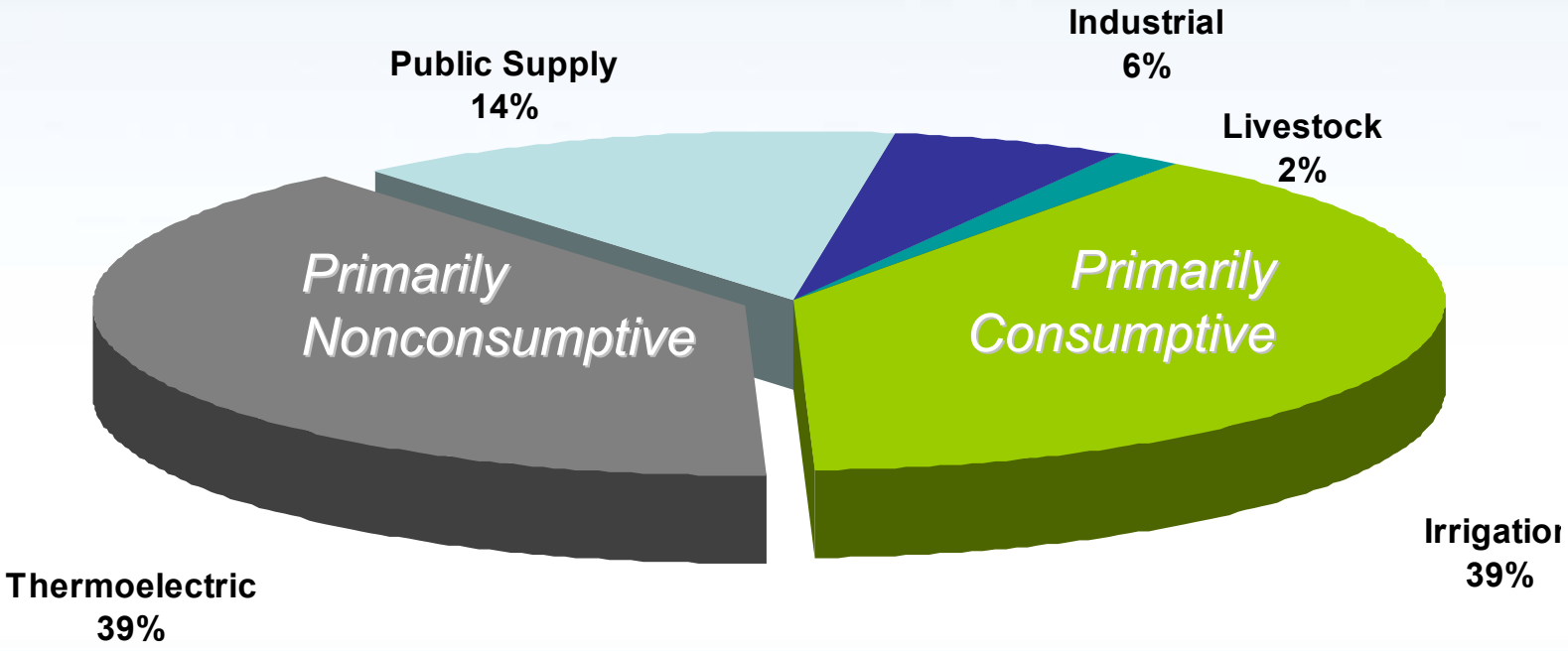


Water production, processing, distribution, and end-use requires energy:

- Pumping
- Conveyance and Transport
- Treatment
- Use conditioning
- Surface and Ground water

Energy and Agriculture withdraw the most water in the U.S.

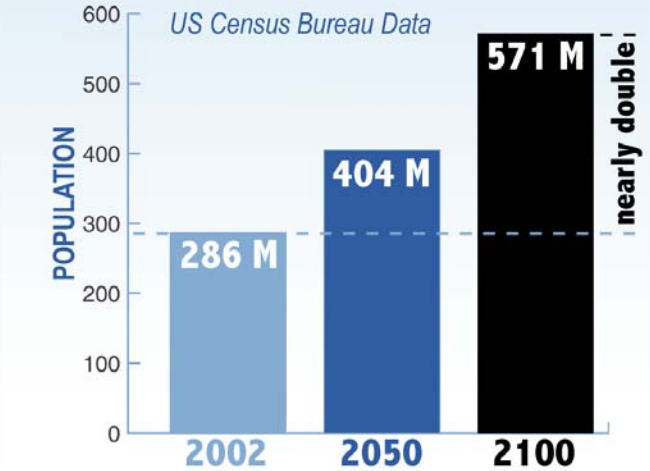
Estimated Freshwater Withdrawals by Sector, 2000

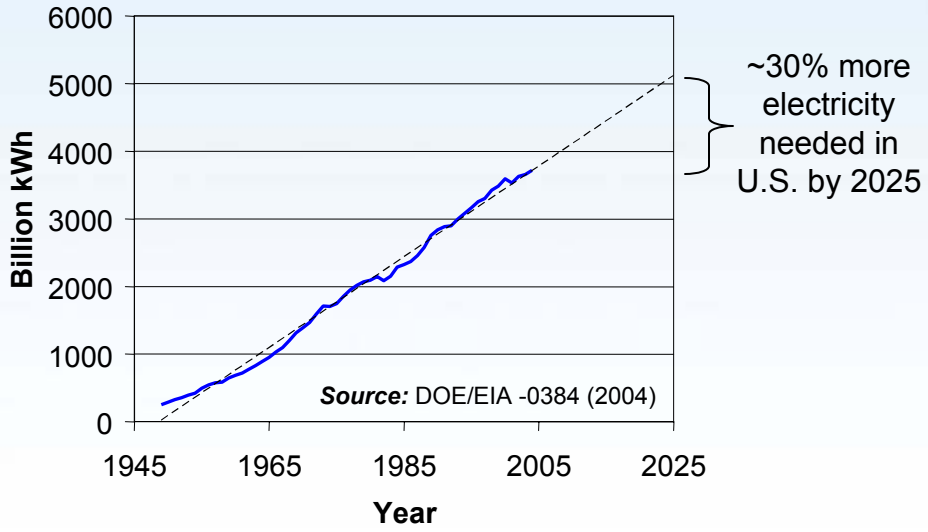


Source: USGS Circular 1268, March, 2004

Note: Hydropower uses are not included here!

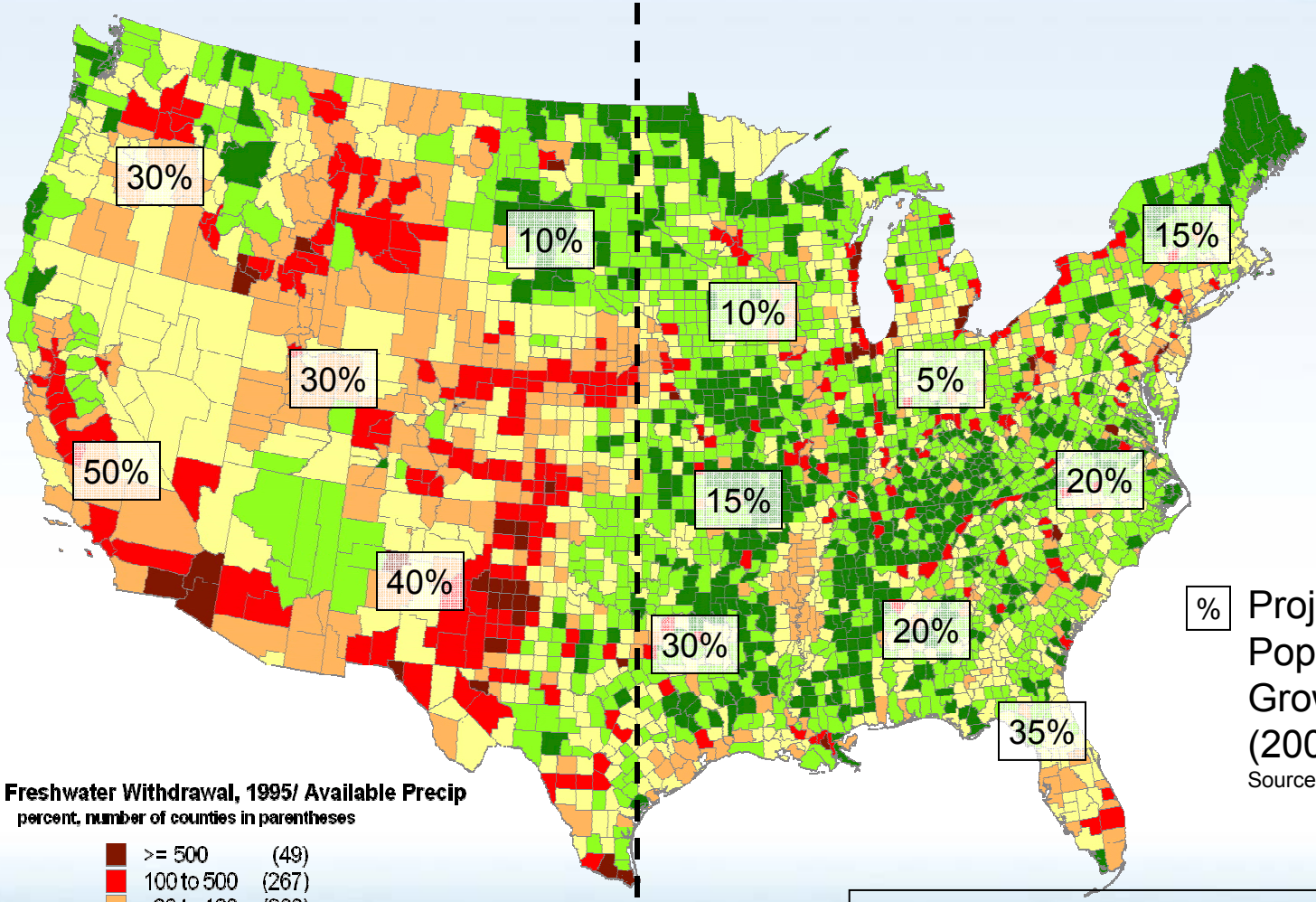
Will water supplies be sufficient to meet future energy demands?





- Population will increase significantly; fresh water supplies will not
  - Most of the population increases are in water-challenged regions
- Energy industry must compete for water with agriculture, other industries, domestic use, and environmental needs
- Climate variability and energy-industry operations could impact water supplies, quality, and energy demand

Water challenges are nationwide



% Projected Population Growth (2000-2020)

Source: NETL (2002)

Source: USGS Circular 1200 (Year 1995), EPRI 2003

Heavy reliance on irrigation in agriculture

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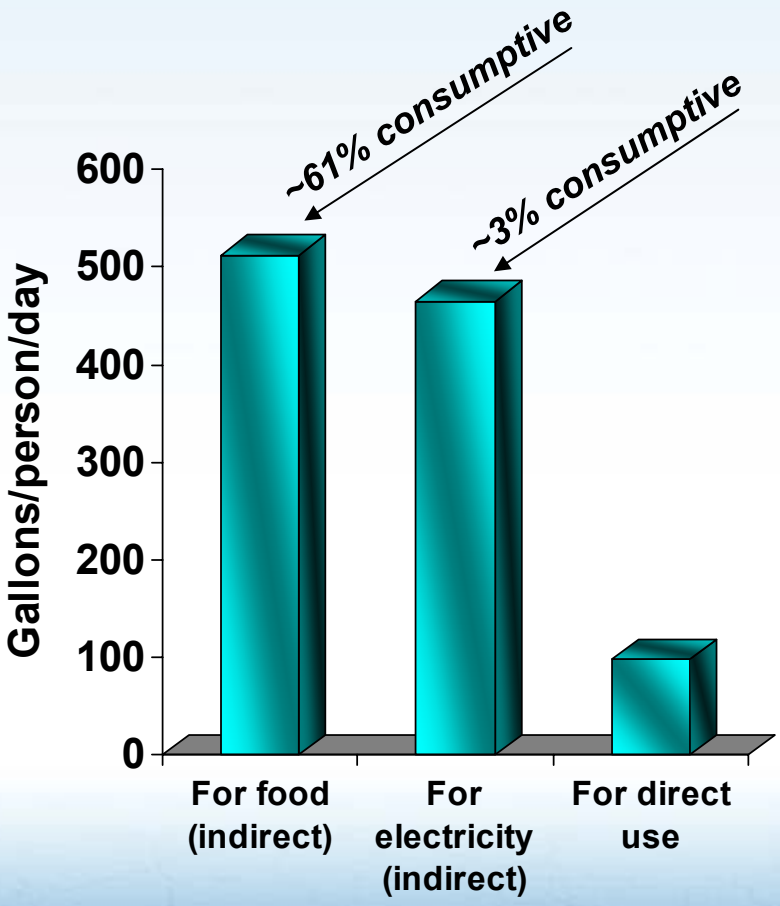
Water for Energy

Water needed to produce household electricity exceeds direct household water use



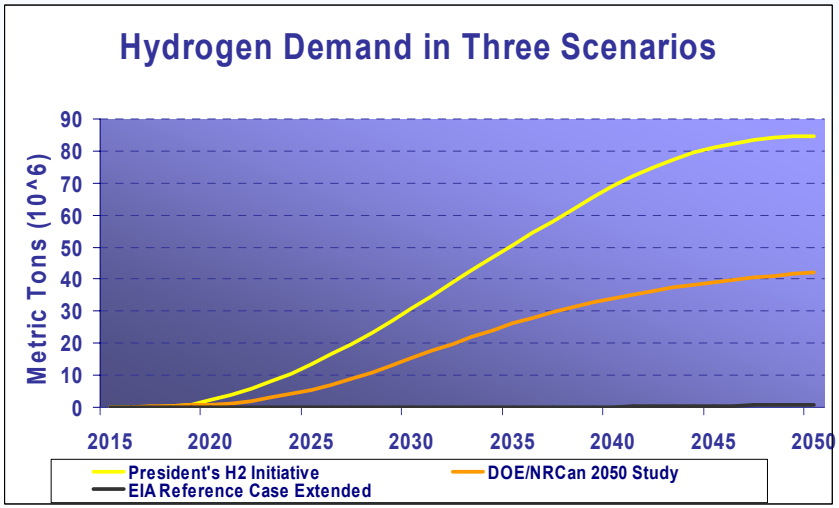
GALLONS PER PERSON PER DAY (average)

- **510 for food production**
  - **includes irrigation and livestock**
- **465 to produce household electricity**
  - **Range: 30 to 600 depending on technology**
- **100 direct household use**
  - **includes bathing, laundry, lawn watering, etc.**

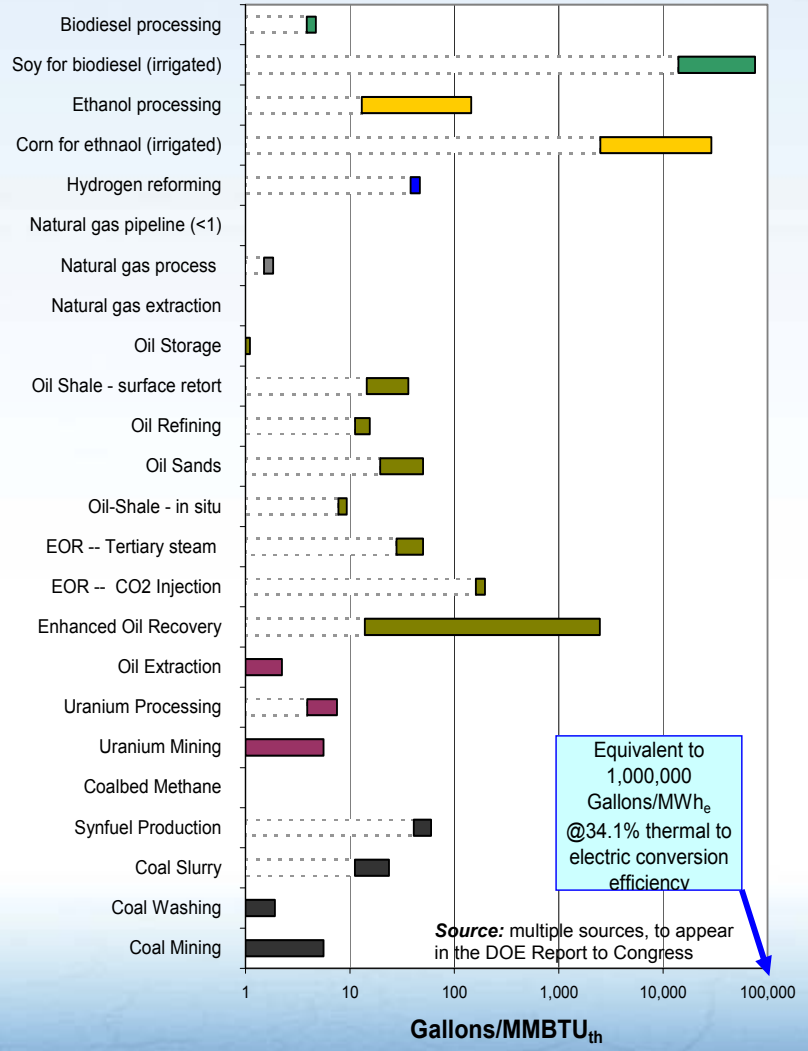
Source: derived from Gleick, P. (2002), *World's Water 2002-2003*.

Future energy development puts new demands on water resources

- Many new technologies will be more water intensive
- Hydrogen economy would require even more water:



- Constraints will grow for energy development and power plant siting



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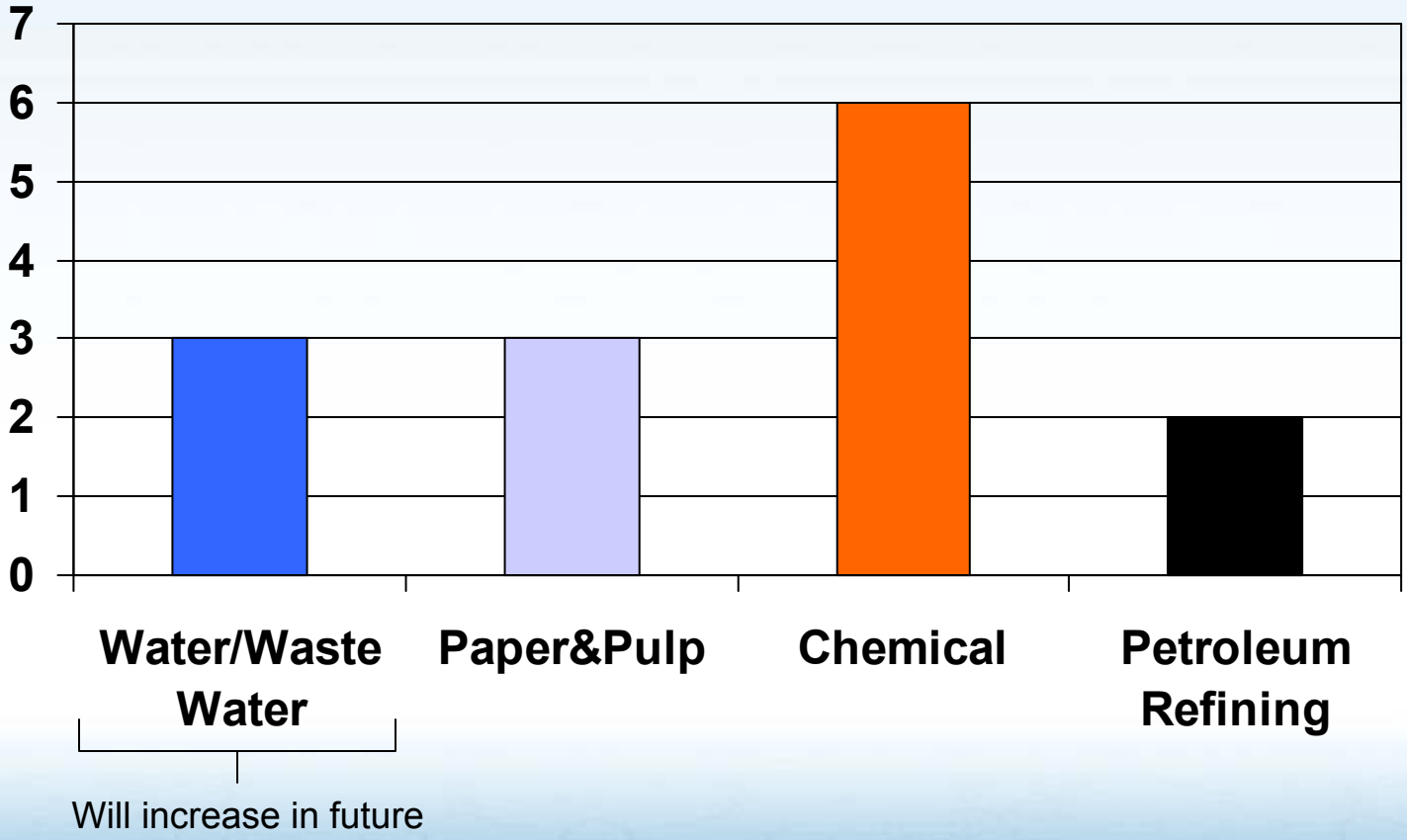
Energy for Water

Currently the Water/Wastewater Sector is a Major User of Electricity

Percent of U.S. Electricity Generation Used by Industry

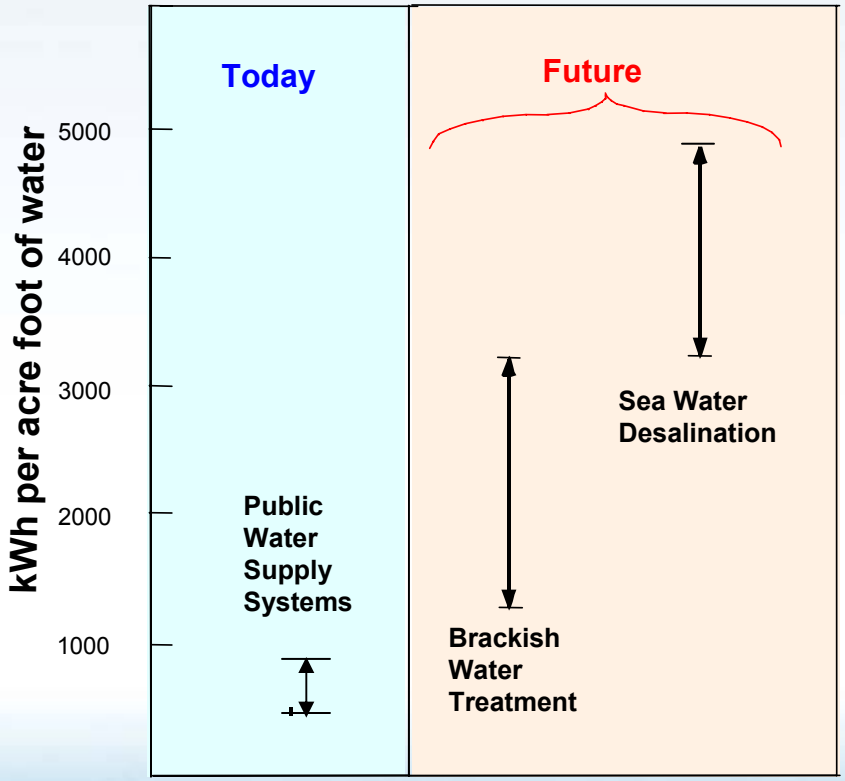
Source: DOE, 2004



Future water supplies & treatment will be more energy intensive

- Readily accessible fresh water supplies are limited and have been fully allocated in some areas
  - Pumping at deeper depths and over longer conveyance distance requires more energy
- New technologies to access and/or treat non-traditional water resources will require more energy per gallon of water
  - Impaired water, produced water, brackish water, and sea water

Power requirements for current and future water supply



Source: EPRI, 2000; Water Desalination Task Force, 2003

Energy - Water Interdependency Issues Are Appearing Now

- Water rates in the Las Vegas Valley will go up . . . because of increased electricity costs (Las Vegas SUN, 2002)
- Utility regulators put ecology ahead of electricity in rejecting a major power plant . . . . that would use 2,500 gallons per minute to cool its steam turbines (Arizona Daily Sun 2002)
- Georgia Power Loses Bid to Draw Water from Chattahooche (Miami Herald, February 2002)
- EPA Orders Mass. Power Plant to Reduce Water Withdrawals (Providence Journal, RI, July 2002)
- Idaho Denies Water Rights Request for Power Plants (U.S. Water News Online, August 2002)
- Pennsylvania Nuclear Power Plant to Use Wastewater from Coal Mines (The Philadelphia Inquirer, July 2003)
- Utilities Warn of Power Crunch if Flows Are Cut (Greenwire, July 2003)
- Governor Mike Rounds of South Dakota called for a summit to discuss drought-induced low flows on the Missouri River and the impacts on irrigation, drinking-water systems, and power plants (News Release, February 2005)

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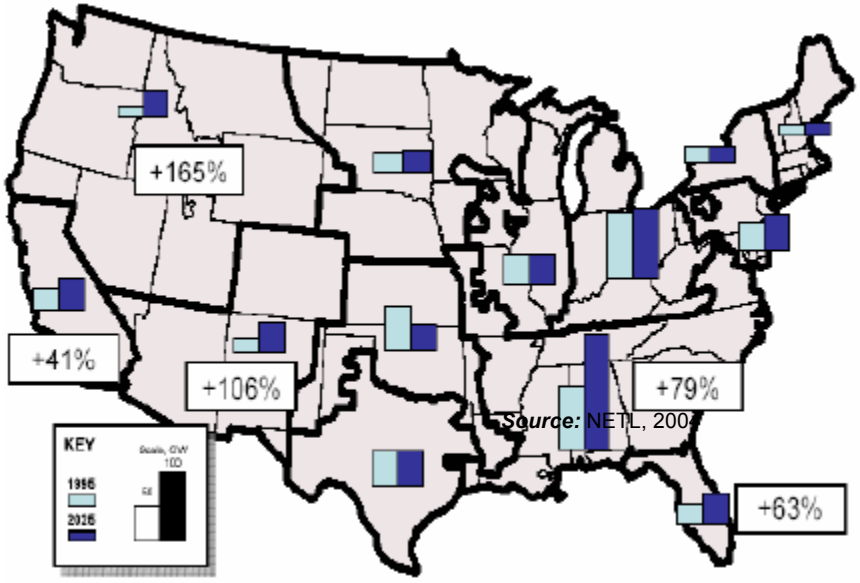
Energy - Water issues align with DOE responsibilities

- **DOE's Energy Strategic Goal is at risk if water needs are not considered**
  - *"promote a diverse supply … of reliable, affordable and environmentally sound energy"*

Projected Thermoelectric Increases

(Capacity in 2025 vs 1995)

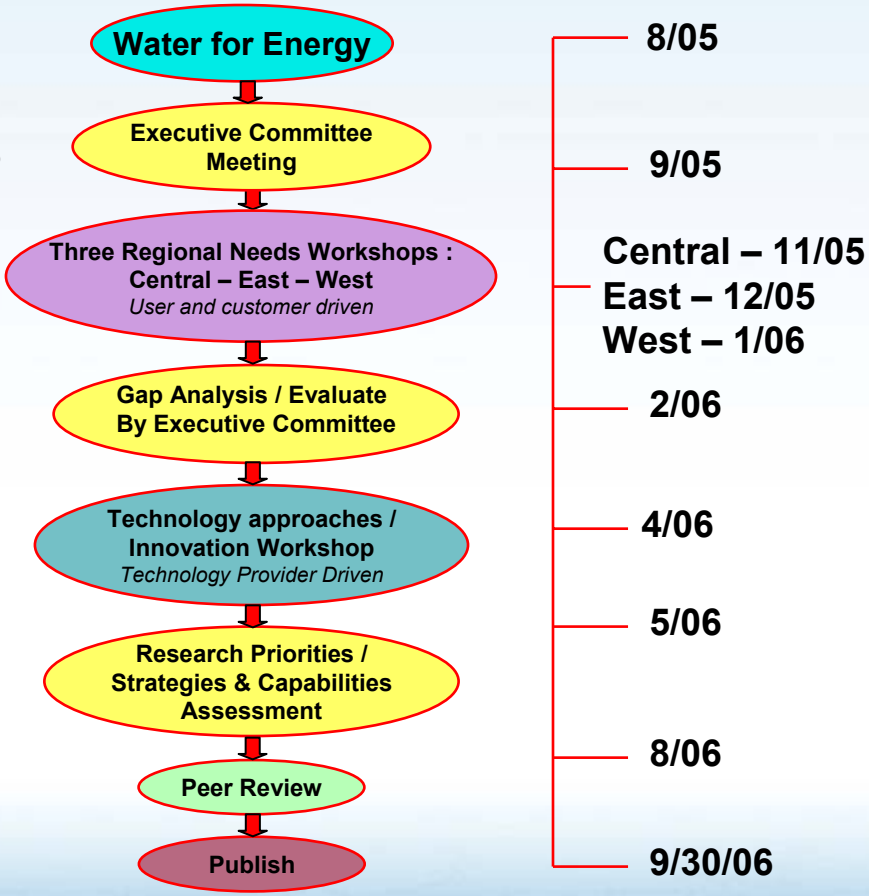


FY05 appropriations are now supporting two Energy-Water efforts

- Report to Congress
  - **Consider energy and water interdependencies, trends in energy and water supplies, threats and concerns to energy production**
  - **Due to Congress from DOE by March 2006**
- Energy-Water Roadmap for DOE
  - **Assess emerging energy and water resource issues based on user and stakeholder needs**
  - **Develop energy and water science and technology priorities**
  - **Due to DOE by September 2006**

National Energy-Water S&T Roadmap Process and Schedule

Executive committee consists of ~ 20 esteemed members from industry, government, and academic institutions to provide external direction and review of process.



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Energy-Water S&T Roadmap Planning and Implementation Team

- Sandia National Laboratories
  - Coordinate roadmap efforts – needs and technology workshops, gap analysis, ranking efforts, and roadmap report
  - www.sandia.gov/energy-water/
- Executive Committee
  - Representatives from - energy utilities, water management groups, environmental groups, energy and water regulators, utility associations, oil and gas, natural resource experts
- National Lab Advisory Team (Energy-Water Nexus Team)
  - Support science and technology issues analysis
- UNM Utton Transboundary Center and Lawrence Berkeley National Laboratory
  - Coordinate policy, regulatory, and economic issues analysis

Goals of Regional Energy-Water Needs Assessment Workshops

- Identify major regional issues, concerns, and trends associated with water availability for future energy production and energy for water
- Help rank regional needs and priorities, and identify current science & technology gaps
- Provide input on possible research, development, demonstration, and technology transfer & commercialization opportunities

Examples of Science and Technology Desired to Address Energy-Water Problems and Needs

- Improved materials, processes, or technologies to enhance efficiency or performance of energy production, cooling, water treatment, etc.
- Science-based regulations and policies
- Improved understanding of chemical and biological processes that impact water and energy-use efficiency
- Modeling and decision-support tools for improved cooperation of resource management and utilization
- Improved technology transfer and economic evaluations of costs and benefits
- Real-time resource sensing, measurement, and monitoring
- Better understanding and evaluation of future energy and water alternatives

National Impact of Energy-Water Science and Technology Roadmap

- Understand the interdependencies of energy and water demands and supplies
- Ensure regional water availability for energy
- Balance future water demands across energy and other sectors and stakeholders
- Develop directions for reducing water intensity in energy systems
- Identify opportunities for reducing energy intensity in water systems